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Bay Delta Conservation Plan

Delta Science Program Independent Science Review

Bay Delta Conservation Plan Effects Analysis Review – Phase 2

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Purpose of Presentation

- Highlights major conclusions and methods used in the Effects Analysis
- Provides Science Panel with an opportunity to engage with authors
- Provides overview of the current status and anticipated path towards a public draft Effects Analysis

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Overview of Presentation

- Conservation measure overview
- Methods and appendix status update
- Effects on ecosystems and communities
- Net effects on each covered fish species
- Net effects on covered terrestrial species (overall, and examples)
- Questions and answers

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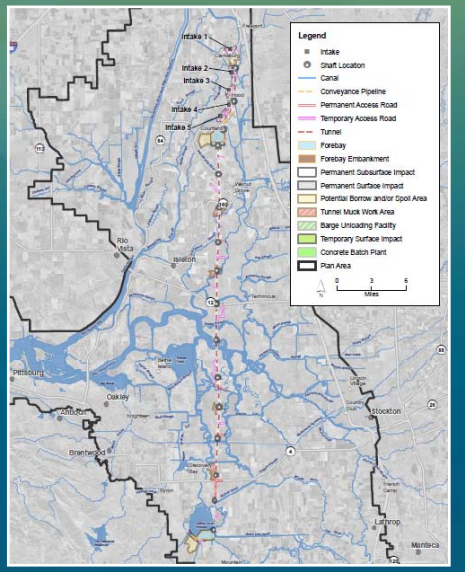
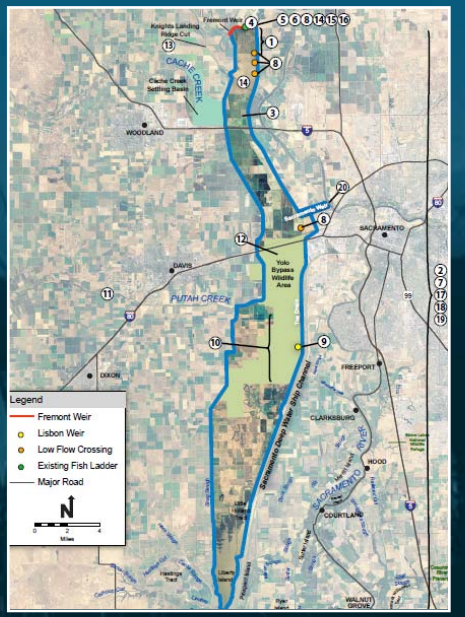
Conservation Measures (Section 3.4)

Two measures primarily affect flow

- CM1 *Water Facilities and Operations*
  - Five new intakes on Sacramento River
  - New dual operations of north and south Delta pumps
- CM2 *Yolo Bypass Fisheries Enhancement*
  - Yolo Bypass modified to increase frequency, duration, and magnitude of floodplain inundation
  - New operational rules





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Conservation Measures

Two measures to create and manage reserve system

- CM3 *Natural Communities Protection and Restoration*
  - *Valley/Foothill Riparian Woodland: 750 acres*
  - *Vernal Pool Complex: 600 acres*
  - *Alkali Seasonal Wetland Complex: 150 acres*
  - *Grassland: 8,000 acres*
  - *Managed Marsh: 1,500 acres*
  - *Cultivated lands: 27,500 acres (est.)*
  - *Total acquisition (excl. restoration sites): 38,500 acres*
- CM11 *Natural Communities Enhancement and Management*

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Conservation Measures

Eight measures focused on restoration

- CM4 *Tidal Natural Communities*: 65,000 acres
- CM12 *Methylmercury Management*
- CM5 *Seasonally Inundated Floodplain:* 10,000 acres
- CM6 *Channel Margin Enhancement:* 20 miles
- CM7 *Riparian Natural Community*: 5,000 acres
- CM8 *Grassland Natural Community*: 2,000 acres
- CM9 *Vernal Pool Complex:* up to 89 acres (est.)
- CM10 *Nontidal Marsh Restoration*: 400 acres

Acquisition + Restoration = 121,000 acres
(14% of Plan Area)

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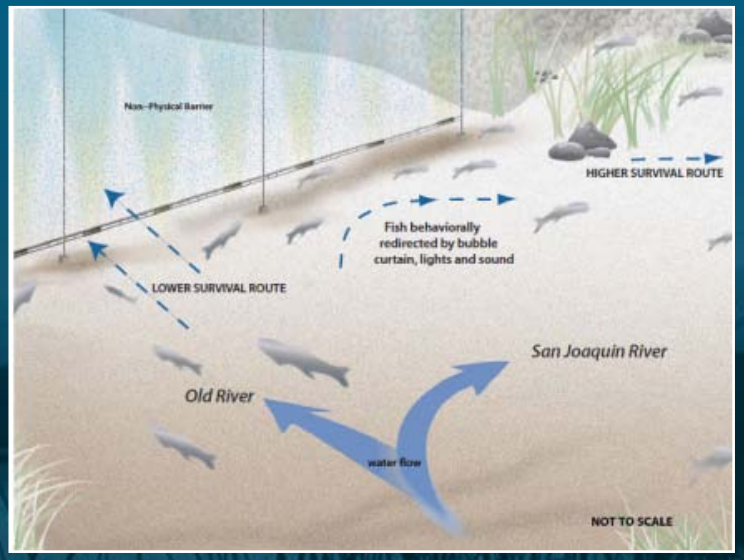
Conservation Measures

Nine measures address "other stressors" for covered fish

- CM13 *Invasive Aquatic Vegetation Control*
- CM14 *Stockton Deep Water Ship Channel Dissolved Oxygen Levels*
- CM15 *Predator Control*
- CM16 *Nonphysical Fish Barriers*
- CM17 *Illegal Harvest Reduction*



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Conservation Measures

- CM18 *Conservation Hatcheries*
- CM19 *Urban Stormwater Treatment*
- CM20 *Recreational Users Invasive Species Program*
- CM21 *Nonproject Diversions*

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Adaptive Management and Monitoring Program (Section 3.6)

- Adaptive management and monitoring help to address uncertainty
- **Compliance monitoring** determines whether BDCP is being implemented as intended
- **Effectiveness monitoring** determines whether the conservation measures are working as intended, and whether the covered species and natural communities are benefiting from them
- New appendix on web: Monitoring and Research Actions (Appendix 3.E)

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Adaptive Management and the Effects Analysis

- How the effects analysis considers adaptive management
  - Anticipates implementation of some conservation measures in an experimental context
  - Apply (multiple) techniques for short duration, small scale
  - Adjust techniques based on results to "scale up"
  - Different from operational changes that respond to observed conditions (e.g., real-time water operations)
  - Examples include
    - Tidal Wetland Restoration (CM4)
    - Invasive Aquatic Vegetation Control (CM13)
    - Predator Control (CM15)
    - Nonphysical Fish Barriers (CM16)
  - Qualitative consideration

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Effects Analysis: Purposes

- Provide necessary information for permitting
  - Endangered Species Act
  - Natural Community Conservation Planning Act
- Provide foundation for alternatives analysis
- Determine overall effects on covered species and natural communities as a result of BDCP
- Includes only analyses for biological effects
- Does not include evaluation of alternatives

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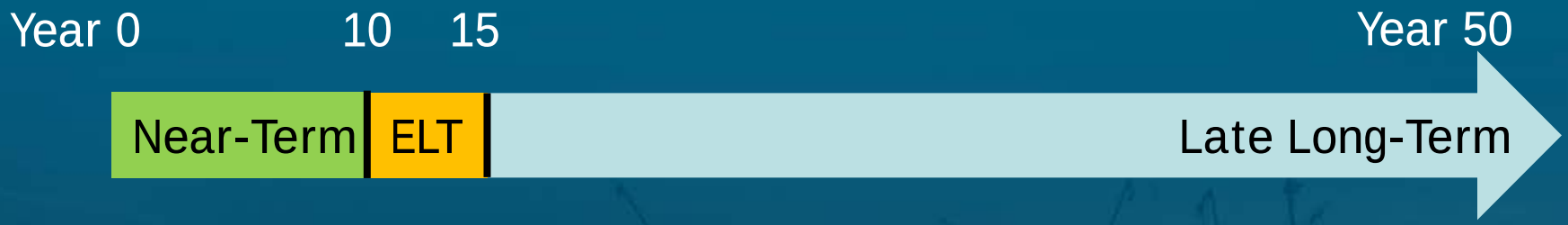
Overview of Comparisons Made

- Existing biological condition without Fall X2 (EBC1)
- Biological condition with Fall X2 (EBC2)
  - In two time periods:
    Early-long term (ELT) and Late-long term (LLT)



- Preliminary proposal (PP_ELT; PP_LLT)
- Comparisons were made between PP scenarios and each baseline condition
- Incorporates protective measures of 2008, 2009 Biological Opinions

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Appendix Status Update

Appendix	Available to the Panel
A: Analytical Framework/Conceptual Foundation	August 30, 2011
B: Entrainment	April 6, 2012
C: Flow, Passage, Salinity, and Turbidity	April 13, 2012
D: Contaminants	March 19, 2012
E: Habitat Restoration	January 13, 2012
F: Ecological Effects	March 19, 2012
G: Life Cycle Models	November 24, 2012
H: Construction Effects on Fish	February 29, 2012
I: Other Analyses	n/a
J: Scenario 6	February 29, 2012
K: Terrestrial Effects	February 29, 2012

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Effects Analysis Work in Progress

- Continued coordination with the agencies to address red-flag comments
- Revisions to Chapter 5 to separate salmonid runs and better justify certainty scores
- Work with agencies to develop appropriate starting distributions for delta smelt and longfin smelt
- Revising turbidity analysis to account for changes in Sacramento River sources due to new intakes
- Additional coordination needed with agencies regarding predation at north Delta intakes

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Habitat Restoration and Life Cycle Model Appendices (E & G)

- Updating Habitat Appendix
  - Updated Habitat Suitability Indices (HSI) for delta smelt and salmonids per agency comments
  - Longfin smelt HSI
  - Application of the HSI to the entire Plan Area
  - Analysis of riparian and floodplain restoration effects
- Updating Life Cycle Model Appendix
  - OBAN: Inclusion of the north Delta intakes
  - IOS: Revised Delta Passage Model results
  - Maunder-Deriso: Sensitivity analyses in coordination with the agencies

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Effects Analysis Organization

- 5.1 Intro and Summary of Conclusions
- 5.2 Overview of Methods
- 5.3 Effects on Ecosystems
- 5.4 Effects on Natural Communities
- 5.5 Effects on Covered Fish (11)
  - Beneficial effects
  - Adverse effects
  - Impact of the Take on Species
  - Net effects
- 5.6 Effects on Covered Wildlife and Plants (49)

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Ecosystem, Landscape, and Natural Community Effects of the Preliminary Proposal

- System-wide changes in flow, temperature
- Changes in salinity, turbidity, dissolved oxygen, and contaminants in the Delta
- Habitat Restoration/Foodweb Productivity

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Preliminary Proposal System-Wide Changes in Flow and Temperature

- Reduces unnatural north to south flows through Delta
- Reduces outflow in some key migration and transport periods
- Slightly increases upstream temperatures
- Climate-change drives major changes in upstream and Delta temperatures

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Changes in Salinity, Turbidity, Dissolved Oxygen, and Contaminants in the Delta

- Compared to EBC, the PP and climate change shift salinity to the east
- Turbidity varies by location (further analysis underway)
- Dissolved oxygen generally improved through restoration and specific actions such as Stockton Deep Water Ship Channel improvements
- Contaminant mobilization from restoration and construction

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Habitat Restoration/ Foodweb Productivity

- Increased production from tidal wetland restoration
  - Primarily in Cache Slough, Suisun Marsh, and south Delta (LLT)
  - Uncertainty about quantity, export to areas where fish exist, and competition (i.e., *Corbula/Corbicula*)

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Covered Fish Net Effects

SACRAMENTO SPLITTAIL

GREEN AND WHITE STURGEON

CHINOOK SALMON

winter, spring, fall and late fall

CENTRAL VALLEY STEELHEAD

PACIFIC AND RIVER LAMPREY

DELTA SMELT

LONGFIN SMELT

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Challenges with Net Effects Analysis

- Mix of quantitative and qualitative models
- Much debate about appropriate methods and interpretations
- No life cycle models available that integrate all effects
  - Cannot quantitatively examine interaction effects, synergies, population responses
  - Cannot perform “sensitivity analysis”
- Climate change
- Wide range of uncertainty in results

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Overview of Net Effects

- **Qualitative** assessment of net effects
  - Based on qualitative and quantitative modeling and analyses
- Systematic, comprehensive, and transparent
- Delta smelt, longfin smelt, salmonids, Sacramento splittail
- Does NOT take into account expected benefits of adaptive limits for water operations

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Method for Net Effects Determination

1. Rank stressors as limiting factors on species/lifestages
2. Rank impact of BDCP on the stressors for species/lifestages
3. Combine positive and negative scores for stressors to determine net effects
4. Determine overall certainty of net effects determination

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Procedure for Integrating BDCP Impacts

Species/lifestage Stressor Rank (0 to 4) X BDCP impact on stressor (-4 to 4) = BDCP Species Impact: Conclusion by stressor

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Species/lifestage stressor certainty rating (1-4) X BDCP impact certainty rating (1-4) = Certainty rating for BDCP impact conclusion

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Net Effects Summaries

- Methods and appendix sections for results are indicated in square brackets
  - E.g., [USFWS regressions, E.6.1.5]
- Results all refer to Late Long-Term (2060)
- Conclusions regarding changes are shown in italics
  - E.g., *high change (4), moderately low certainty (2)*

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Delta Smelt: Stressor Rankings

Stressor Category	Stressors	Spawned Eggs to Hatching	Hatch to Fully Developed Fins and Air Bladder	Actively Feeding and Growing	Sexually Mature and Migrating Fish
		Eggs	Larvae	Juveniles	Adults
Food	Food resources	0	4	4	0
	Competition for food	0	3	3	0
	Nutrient balance	0	3	3	0
Water Operations	Transport flows	0	0	0	0
	Alternative channels	0	0	0	0
	Passage barriers	0	0	1	1
Water Operations—Entrainment	North Delta entrainment/ impingement	0	1	1	1
	South Delta entrainment	0	2	2	2
	North Bay Aqueduct entrainment	0	1	0	0
	Agricultural diversion entrainment	0	1	1	1
Habitat	Tidal habitat	1	2	2	1
	Channel margin	1	0	0	0
	Floodplains	0	0	0	0
	Low salinity zone	0	0	3	0
	Invasive aquatic vegetation	1	2	2	1
	Temperature	0	2	3	0
	Turbidity	0	4	4	4
	Dissolved oxygen	0	0	0	0
Water Quality	Contaminants	1	1	1	1
	Microcystis toxicity	0	0	2	0
Predation	Predation	2	2	2	2
	Harvest	0	0	0	0

High certainty (4)
Moderately high certainty (3)
Moderately low certainty (2)
Low certainty (1)

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Delta Smelt: Beneficial Effects

- Substantial increase in tidal habitat (mostly Cache Slough and Suisun Marsh)
  - Increase in suitable habitat (for occupancy)
    - 28–52,000 habitat units (BDCP) vs. 5,500–12,000 HUs (Existing; only within ROAs) [HSI analysis, E.6.2] ➔ *high change (4), moderately low certainty (2)*
  - Potential increase in food (local consumption and export to open-estuary areas)
    - 49,000 prod-acres (BDCP) vs. 9,000 prod-acres (Existing; only within ROAs) [prod-acres analysis, E.6.2] ➔ *moderately high change (3), moderately low certainty (2) (larvae/juveniles)*

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Delta Smelt: Beneficial Effects

- Entrainment similar to or lower than post-BiOp conditions
  - South Delta: 5.5% of adults (BDCP) vs. 7.5% of adults (Existing) [USFWS (2008) regression, B.6.1.5.2] ➔ *moderately low change (2), moderately high certainty (3)*
  - South Delta: 14% of larvae/juveniles (both BDCP and Existing) [USFWS (2008) regression, B.6.1.5.1] ➔ *no change (0), moderately high certainty (3)*
  - Also minor changes from agricultural diversions and North Bay Aqueduct (positive) and north Delta intakes (negative)

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Delta Smelt: Adverse Effects

- Reduced fall abiotic habitat for juveniles
  - [Feyrer et al. (2011) fall abiotic habitat index, C.5.4.7]

Existing (No BiOp Fall X2)	Existing (BiOp Fall X2)	BDCP (0% Restoration)	BDCP (100% Restoration
~4,000 hectares	~4,900 hectares	~3,800 hectares	~4,800 hectares

  - *Moderately low negative change (-2), low certainty (1)*
  - Targeted research and adaptive management would be necessary to inform importance and uncertainty

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Delta Smelt: Adverse Effects

- Greater exposure to *Microcystis*
  - Greater upstream extent of juvenile delta smelt with lower summer/fall outflow [Qualitative analysis, F.4]
  - *Low negative change (-1) with low certainty (1)*
- Greater competition for food (*Corbula*)
  - Greater extent of *Corbula* suitable habitat (lower fall outflow) [Qualitative analysis, F.5]
  - *Low negative change (-1) with low certainty (1)*

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Delta Smelt: Other Stressors Considered

- Potential minor benefit from predation reduction; minor adverse effects from contaminants and construction
- No change in ammonium, Plan Area water temperature
- CM13 (Invasive aquatic vegetation control) limited to restored areas only
- CM16 (Non-physical barriers) more related to juvenile salmonid migration
- No conclusion regarding turbidity

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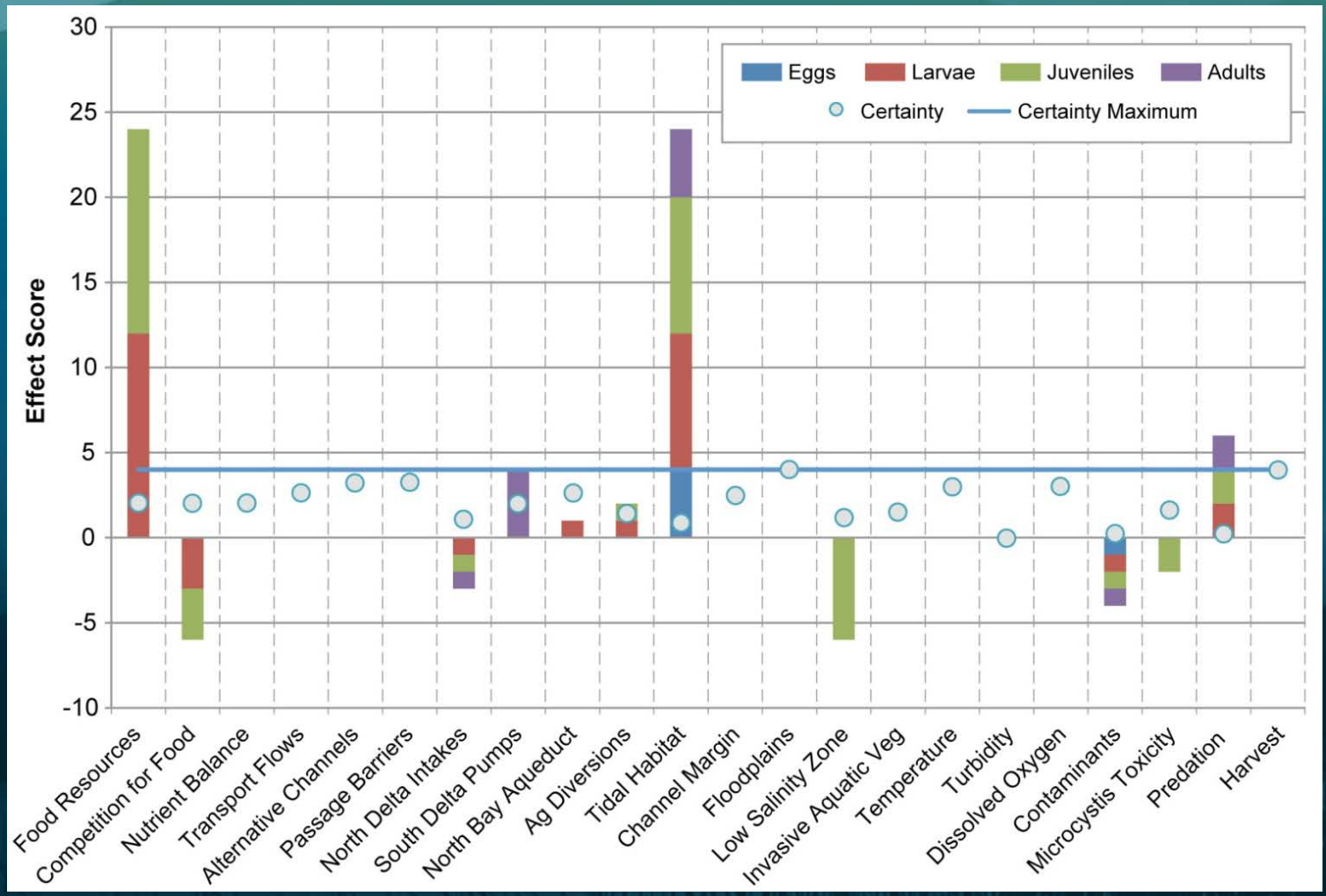
Delta Smelt: Net Effects

- Minor beneficial effect, some uncertainty



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Longfin Smelt: Stressor Rankings

Stressor Category	Stressors	Spawned Eggs to Hatching	Hatch to Fully Developed Fins and Air Bladder	Actively Feeding and Growing	Sexually Mature and Migrating Fish
		Eggs	Larvae	Juveniles	Adults
Food	Food resources	0	4	3	3
	Competition for food	0	3	3	0
	Nutrient balance	0	3	3	0
Water Operations	Transport flows	0	4	4	0
	Alternative channels	0	0	0	0
	Passage barriers	0	0	1	0
Water Operations—Entrainment	North Delta entrainment/impingement	0	1	1	1
	South Delta entrainment	0	2	2	1
	North Bay Aqueduct entrainment	0	1	0	0
	Agricultural diversion entrainment	0	1	0	0
Habitat	Tidal habitat	1	1	1	0
	Channel margin	1	0	0	0
	Floodplains	0	0	0	0
	Low salinity zone	0	3	2	1
	Invasive aquatic vegetation	2	2	2	0
	Temperature	0	3	2	0
	Turbidity	0	3	4	0
	Dissolved oxygen	0	0	0	0
Water Quality	Contaminants	0	2	2	0
	Microcystis toxicity	0	0	0	1
Predation	Predation	2	2	2	1
	Harvest	0	0	0	1

High certainty (4)
Moderately high certainty (3)
Moderately low certainty (2)
Low certainty (1)

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Longfin Smelt: Beneficial Effects

- Substantial increase in tidal habitat (mostly Cache Slough and Suisun Marsh)
  - Increase in suitable habitat (for occupancy)
    - Qualitative analysis [E.6.2] ➔ *moderately high change (3), moderately low certainty (2) for eggs, larvae, juveniles*
  - Potential increase in food (local consumption and export to open-estuary areas)
    - 49,000 prod-acres (BDCP) vs. 9,000 prod-acres (Existing; only within ROAs) [prod-acres analysis, E.6.2] ➔ *moderately low/high change (larvae/juvenile 2, adult 3), moderately low certainty (2)*

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Longfin Smelt: Beneficial Effects

- Entrainment similar to or lower than post-BiOp conditions
  - South Delta: ~50% lower entrainment of adults (BDCP vs. Existing), juveniles similar [Salvage-density method, B.6.1.6] ➔ *adults moderately low change (2), juveniles no change, moderately high certainty (3)*
  - South Delta: Larvae variable but generally lower under BDCP [Particle tracking, B.6.1.6.1] ➔ *low positive change (1), moderately high certainty (3)*
  - Also minor changes from agricultural diversions and NBA (positive) and north Delta intakes (negative)

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Longfin Smelt: Adverse Effects

- Lower outflow during larval/juvenile period

  Based on Kimmerer et al. (2009) X2-abundance regression, reduction in abundance index

Water Year Type	Fall Midwater Trawl			Bay Midwater Trawl			Bay Otter Trawl		
	Exist.	BDCP	Diff.	Exist.	BDCP	Diff.	Exist.	BDCP	Diff.
All	3,678	3,382	-8%	7,563	6,838	-10%	9,522	8,609	-10%
Wet	11,789	11,665	-1%	30,604	30,218	-1%	38,528	38,042	-1%
Abv. Nor.	5,752	4,867	-15%	12,937	10,587	-18%	16,286	13,328	-18%
Blw. Nor.	2,978	2,558	-14%	5,872	4,892	-17%	7,393	6,159	-17%
Dry	1,626	1,482	-9%	2,840	2,540	-11%	3,576	3,198	-11%
Critical	820	767	-6%	1,249	1,153	-8%	1,572	1,452	-8%

- *Moderately high negative change for larvae/juveniles (-3), moderately low certainty (2)*

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Longfin Smelt: Other Stressors Evaluated

- Potential minor benefit from predation reduction; minor adverse effects from contaminants and construction
- No change in ammonium, Plan Area water temperature
- CM13 (Invasive aquatic vegetation control) limited to restored areas only
- CM16 (Non-physical barriers) more related to juvenile salmonid migration
- No conclusion regarding turbidity

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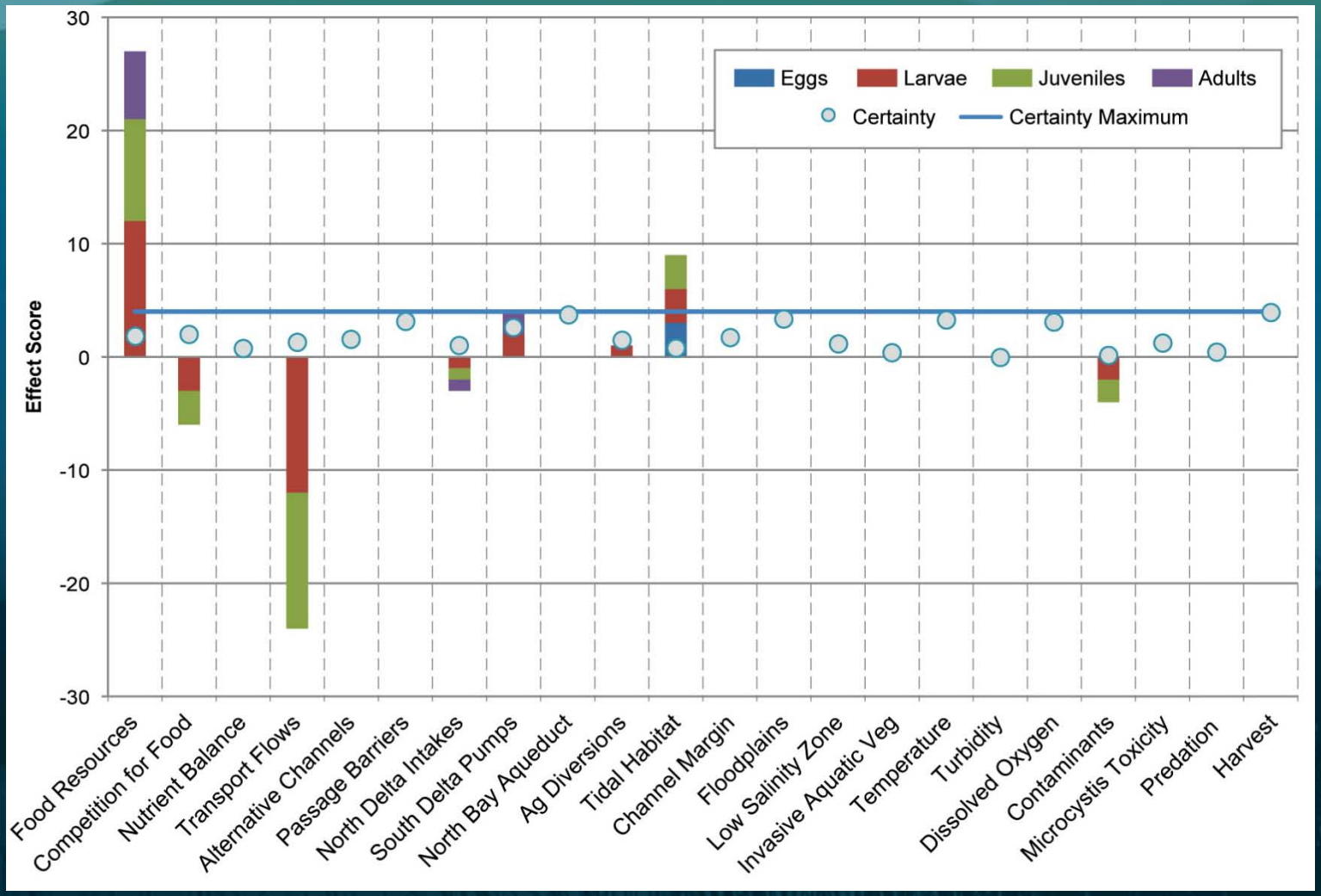
Longfin Smelt: Net Effects

- No net effect, uncertain



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Summary of Net Effects of BDCP on Salmonids

- Analysis treated salmonids as a group
  - New analysis will differentiate species
- Effects on salmonids separated for
  - Delta
  - Rivers (primarily Sacramento River)
- Two juvenile behavior forms in Delta
  - Foraging
  - Migrating

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Stressors on Salmonids in the Delta

		Eggs	Foraging Juveniles	Migrating Juveniles	Adults
Food	Food resources	0	3	2	0
	Competition for food	0	2	2	0
	Nutrient balance	0	1	1	0
Water Operations	Transport flows	0	3	4	2
	Alternative channels	0	3	3	0
	Passage barriers	0	0	0	3
Water Operations — Entrainment	North Delta entrainment/ impingement[1]	0	2	1	0
	South Delta entrainment	0	2	2	0
	North Bay Aqueduct entrainment	0	0	0	0
	Agricultural diversion entrainment	0	1	1	0
Habitat	Tidal habitat	0	4	0	0
	Channel margin	0	4	3	0
	Floodplains	0	4	2	0
	Low salinity zone	0	0	0	0
	Invasive aquatic vegetation	0	2	1	
	Temperature	0	1	2	1
	Turbidity	0	3	3	0
	Dissolved oxygen	0	0	0	0
Water Quality	Contaminants	0	2	2	2
	Microcystis toxicity	0	1	0	0
Predation	Predation	0	3	3	0
	Harvest	0	0	0	1

	High degree of scientific certainty, supported by consistent quantitative analysis.
	Appreciable qualitative information supported by general scientific literature.
	Uncertain, conflicting quantitative analysis, limited support in literature.
	Speculative, no quantitative analysis and little applicable literature.

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Stressors on Salmonids in Rivers

	Eggs	Foraging Juveniles	Migrating Juveniles	Adults
Food Resources	0	1	0	0
Flow regulation	0	3	4	1
Flow-associated habitat	2	1	1	0
Channel margin	0	3	2	0
Floodplain	0	3	2	0
Channel form and substrate	3	2	0	0
Temperature	2	2	2	0
Turbidity	0	0	0	0
Dissolved oxygen	0	0	0	0
Passage barriers	0	1	1	1
Contaminants	0	1	1	0
Predation	0	2	2	0
Harvest	0	0	1	2

Legend

	High degree of scientific certainty, supported by consistent quantitative analysis.
	Appreciable qualitative information supported by general scientific literature.
	Uncertain, conflicting quantitative analysis, limited support in literature.
	Speculative, no quantitative analysis and little applicable literature.

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Delta Salmonids: Beneficial Effects

- Substantial increase in tidal habitat for foraging juvenile salmonids
  - Increase in suitable habitat
    - 5,273 habitat units (Existing) ➔ 19,384 (BDCP)
    - [HSI analysis, E.5.1] ➔ *high change (4), moderately high certainty (3)*
- Potential increase in food for all species
  - 49,000 prod-acres (BDCP) vs. 9,000 prod-acres
  - (Existing; only within ROAs)
    [prod-acres analysis, E.6.2] ➔ *moderately high change (3), moderately high certainty (3)*

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Delta Salmonids: Beneficial Effects

- Overall less entrainment with dual conveyance
  - Generally less South Delta pumping under BDCP, with greater pumping in spring of drier year types
  - South Delta Entrainment [salvage-density method, B.6.1]
    - Winter-run Chinook: 50–90% less in wetter, ~8% less in dry
    - Spring-run Chinook: 65% less in wet, 10–50% **more** in other years
    - Late fall-run Chinook: 20–60% less in wetter, 20% **more** in critical
    - Fall-run Chinook: 70% less in wet, 7–30% **more** in drier
    - Steelhead: 50–85% less in wetter, little difference in drier
  - *Overall, low to moderately high (1 to 3) positive change with moderately low certainty (2)*

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Delta Salmonids: Beneficial Effects

- Access to Yolo Bypass greater for juvenile salmonids, longer flood duration
  - Greater use by migrants [Delta Passage Model, C.5.3.1.3]: Winter-run/spring-run smolts (6–9.5% under Plan vs. 4–7% existing)
  - Greater potential for fry entry [Fry growth analysis, C.5.4.1.3]
- Passage of adult salmonids at Fremont Weir improved [DRERIP, C.5.3.1.8]
  - *Moderately high positive change (3) for juveniles and adults with moderately low to moderately high certainty (2–3)*

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Delta Salmonids: Adverse Effects

- Lower flows below proposed North Delta intakes on Sacramento River
  - 10–20% reduction in flow Jan. to May (main juvenile migration period) [CALSIM flow summary, C.5.3.1.9]
  - 3–8% lower olfactory cues for adults [DSM2-fingerprinting, C.5.3.1.9]
  - Modeled through-Delta smolt survival little changed [Delta Passage Model, C.5.3.1.3]
    - Trade-off of lower Sac. R. flow (-) and Yolo Bypass (+)
  - *Low negative change (-1) for juveniles and adults, moderately low certainty (2)*

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Delta Salmonids: Adverse Effects

- North Delta Intakes may adversely affect juvenile salmonids
  - No entrainment (1.75-mm mesh), minimal effects from screen contact [B.6.2.1]
    - *Low negative change (-1), moderately low certainty (2)*
  - Structures could provide cover for predators and increase predation
    - Bioenenergetics modeling suggests <1% predation around intakes (low certainty,with additional consideration required) [Striped bass bioenergetics model, F.3.2.1]

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Delta Salmonids: Other Effects

- Channel margin enhancement (CM6): Positive effect but spatially limited
- Predation reduction (CM15): Small localized positive effect, low certainty
- Nonphysical barriers (CM16): Potential for improved survival but uncertain
- Illegal harvest (CM18): Small positive effect for adults but uncertain
- Minor adverse effects from contaminants and construction

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Riverine Salmonids: General Effects

- Reservoir operations generally would not be expected to differ under BDCP vs. Existing
- Modeled differences exist primarily because of the need to satisfy USFWS delta smelt BiOp fall X2 requirement under EBC2
  - E.g., adverse effects on winter-run Chinook salmon on the Sacramento River [OBAN life cycle model]
- There also are appreciable effects because of climate change

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Riverine Salmonids: Beneficial Effects

- Flow in Feather and American Rivers increased under BDCP
  - Small positive change from greater flows on spring and fall-run Chinook juveniles [CALSIM flow summary, C.5.3.1.9]

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Riverine Salmonids: Adverse Effects

- De-watering of redds of winter-run Chinook increased (SacEFT)
  - Risk of de-watering: 24% current ➔ 29% plan
- Winter-run Chinook spawning area decreased
  - Good conditions 32% current ➔23% plan
- Decrease in Winter-run Chinook escapement due to climate change and plan (most notable when compared to EBC2)

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Riverine Salmonids: Adverse Effects

- OBAN life cycle model indicates adverse effects on winter-run Chinook
  - ↑ Summer temperature (eggs)
  - ↓ Fall flow
- Increased egg mortality for spring-run Chinook may occur under Preliminary Proposal
  - 5-10% increase in mortality in wetter years (Reclamation Egg Mortality Model)
  - ↑ Water Temperature in Fall
- Other models show no change or positive impact of plan on spring-run Chinook
  - No change (SalMod)
  - Improvement (SacEFT)

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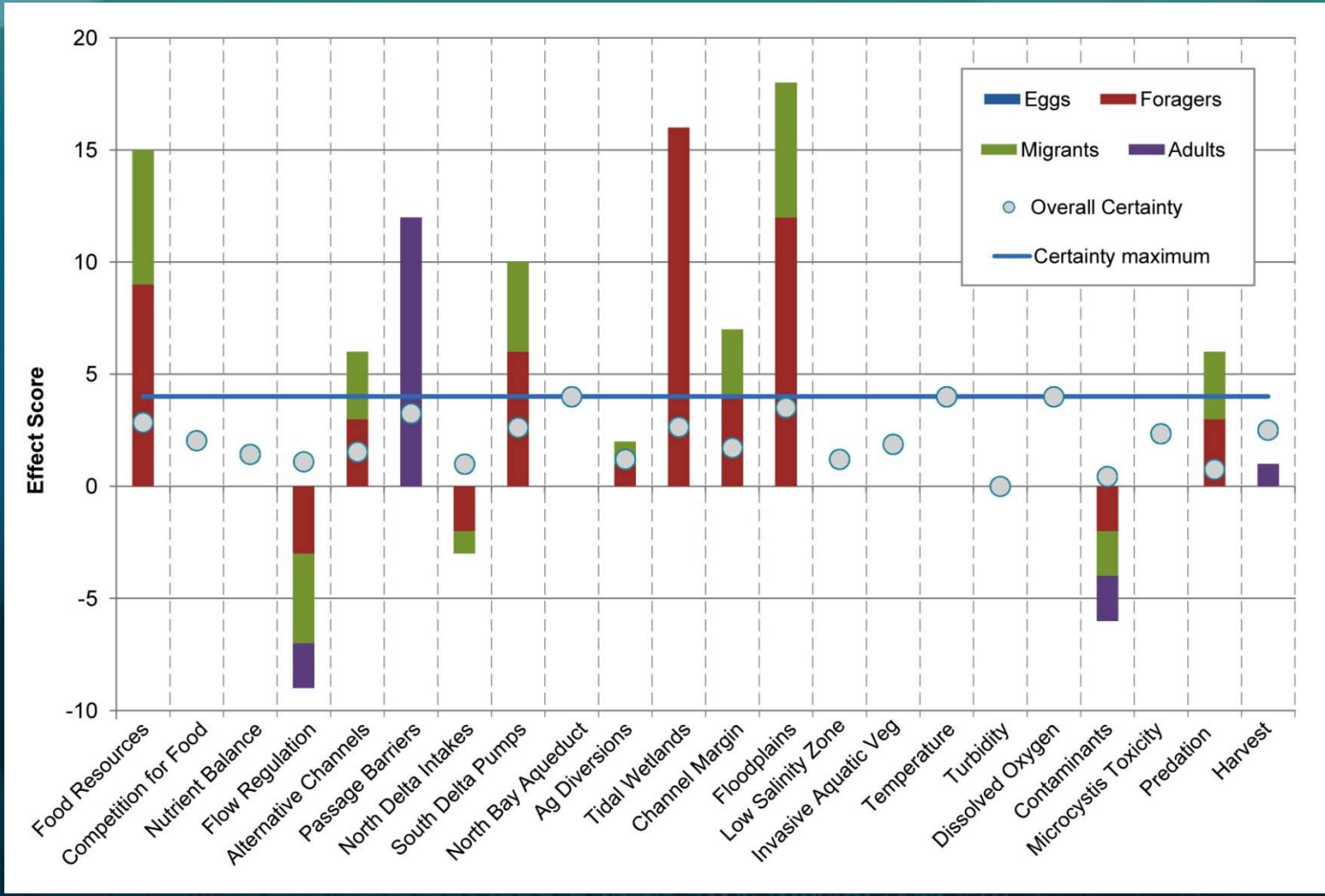
Summary of Net Effects on Salmonids (Delta)

- Net effect is positive, moderate certainty



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Sacramento Splittail: Stressor Rankings

Stressor Category	Stressors	Spawned Eggs to Hatching	Hatch to Fully Developed Fins and Air Bladder	Actively Feeding and Growing	Sexually Mature and Migrating Fish
		Eggs	Larvae	Juveniles	Adults
Food	Food resources	0	0	2	3
	Competition for food	0	0	2	2
	Nutrient balance	0	0	2	0
Water Operations	Transport flows	1	1	0	1
	Alternative channels	0	0	0	0
	Passage barriers	0	0	1	1
Water Operations—Entrainment	North Delta entrainment/impingement	0	1	1	0
	South Delta entrainment	0	0	2	1
	North Bay Aqueduct entrainment	0	0	1	0
	Agricultural diversion entrainment	0	0	1	0
Habitat	Tidal habitat	1	1	3	3
	Channel margin	1	1	3	1
	Floodplains	4	4	0	2
	Low salinity zone	0	0	0	0
	Invasive aquatic vegetation	0	0	2	1
	Temperature	2	2	0	0
	Turbidity	0	0	2	2
	Dissolved oxygen	0	0	0	0
Water Quality	Contaminants	1	2	1	0
	Microcystis toxicity	0	0	1	0
Predation	Predation	1	2	2	1
	Harvest	0	0	0	0

High certainty (4)
Moderately high certainty (3)
Moderately low certainty (2)
Low certainty (1)

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Sacramento Splittail: Beneficial Effects

- Substantially greater access to floodplain habitat (Yolo Bypass enhancements, CM2)
  - Greater spawning/rearing habitat
    - CALSIM/MIKE-21/Habitat suitability [C.5.4.1.1] ➔ *high positive change (4), high certainty (4) for eggs, larvae, adults*

Water Year Type	Existing	Plan	Difference (% Difference)
Wet	1,662	2,645	983 (59%)
Above normal	1,139	1,911	772 (68%)
Below normal	124	490	366 (296%)
Dry	0	15	15 (NA)
Critical	0	5	5 (NA)

  - May also be a considerable benefit for food resources

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Sacramento Splittail: Beneficial Effects

- Greater availability of tidal and channel margin habitat
  - Fourfold increase in subtidal habitat within ROAs
    - HSI [E.6.2] ➔ *high positive change (4); low certainty (1) for eggs/larvae; moderately high certainty (3) for juveniles/adults*
  - 20 linear miles of channel margin enhancement (4–8% of existing habitat)
    - Qualitative assessment [E.6.4.4] ➔ *low positive change (1); moderately low certainty (2) for eggs/larvae, high certainty (4) for juveniles/adults*

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Sacramento Splittail: Beneficial Effects

- Lower entrainment because of dual conveyance
  - Lower south Delta pumping
    - Entrainment is 65% lower under BDCP vs. Existing for juveniles and adults [Salvage-density method based on Delta inflows, B.6.1.7]
    - Number of individuals entrained may increase because of increased floodplain inundation [Salvage-density method based on floodplain inundation, B.6.1.7], but per capita rate would be lower
  - Potential for screen contact/impingement at the north Delta intakes

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Sacramento Splittail: Adverse Effects

- Greater exposure to contaminants
  - Floodplain inundation and habitat restoration effects
    - Qualitative analysis (Appendix 5.D)
    - *Low negative change (-1) for eggs and larvae (moderately low certainty, 2); no change for juveniles and adults*
- Minor adverse effect from in-water construction and maintenance

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Sacramento Splittail: Other Effects

- Potential minor benefit from reduced predation
- No change in ammonium, Plan Area water temperature
- CM13 (Invasive aquatic vegetation control) limited to restored areas only
- CM16 (Non-physical barriers) more related to juvenile salmonid migration
- No conclusion regarding turbidity

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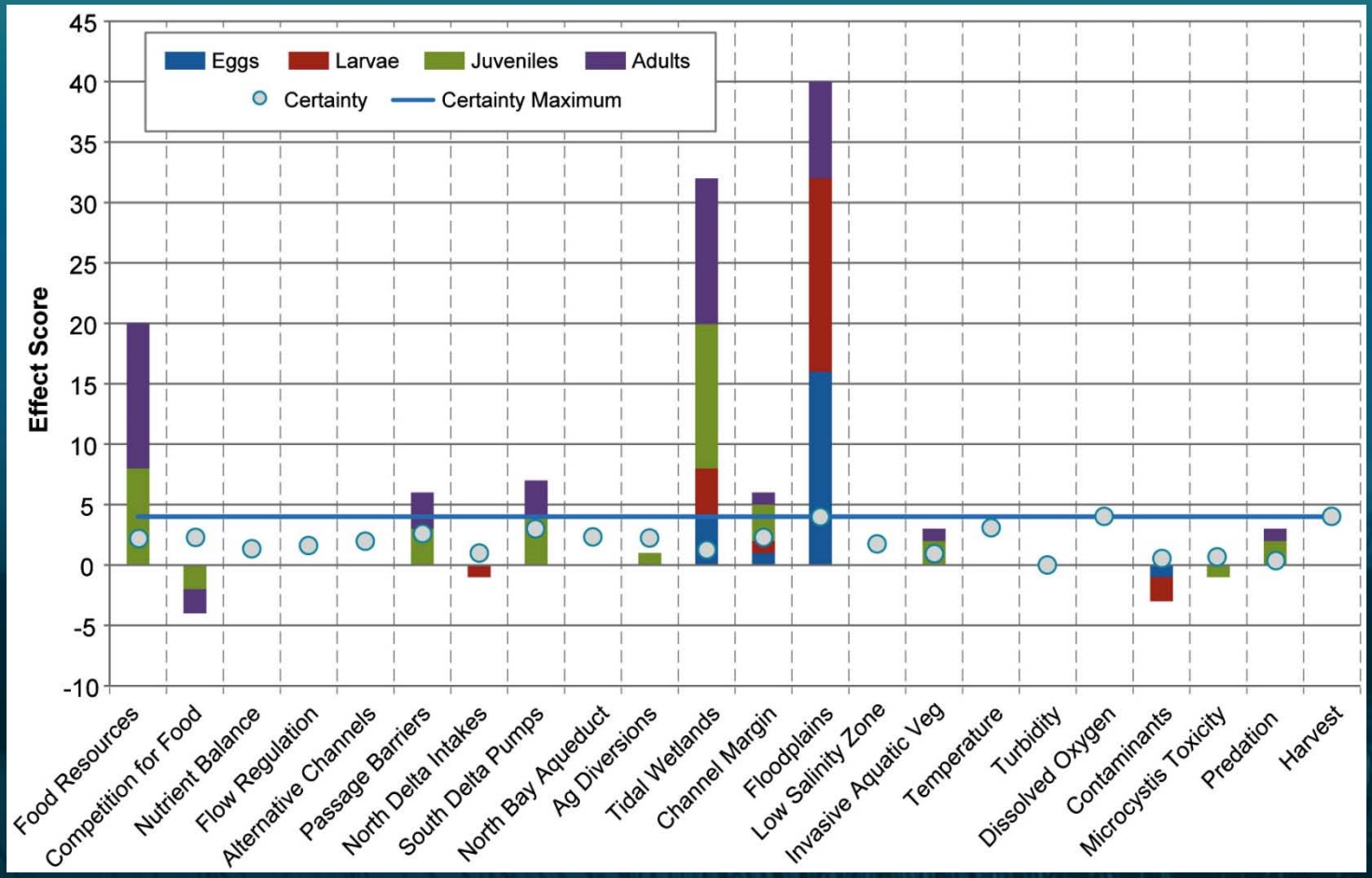
Sacramento Splittail: Net Effects

- Increased abundance, productivity, diversity and improved chances of survival



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Sturgeon and Lamprey: Net Effects

Modified Methods for Net Effects Determination

1. Quantitative description of stressors as limiting factors on species/life stages
2. Description of effects of BDCP on the stressors for species/life stages
3. **Qualitatively** combine positive and negative effects for stressors to determine net effects
4. Determine overall certainty of net effects determination

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Sturgeon: Beneficial Effects

- Reduced Illegal Harvest
  - CM17 Illegal Harvest Management (F.1.1.4)
  - CM2 Yolo Bypass Fisheries Enhancements (C.5.3.1.8)
  - ➔ *Large effect, low certainty*

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Sturgeon: Beneficial Effects

- Improved Passage
  - CM1 Water Facilities and Operations (C.5.3.1.9)
    - Revised DCC operations allow improved migration cues and downstream transport from Sacramento and Feather rivers
  - CM2 Yolo Bypass Fisheries Enhancements (C.5.3.1.8)
  - CM 14 Stockton Deep Water Ship Channel (C.5.3.1.6)
    - White sturgeon only
  - ➔ *Moderate effect, low certainty*

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Sturgeon: Beneficial Effects

- Other minor beneficial effects:
  - Substantially reduced South Delta entrainment (CM1, B.4.1)
  - Improved flows during white sturgeon egg incubation (CM1, C.5.2)
  - Improved food availability (CM2, CM4, CM6, Appendix E)
  - Improved habitat quality and quantity (CM4, CM6, Appendix E)
  - Reduced predation during vulnerable life stages (CM15, F.1.1.2)

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Sturgeon: Adverse Effects

- Reduced April/May Delta outflow
  - Correlated with white sturgeon year class strength (C.5.3.1.9)
  - However, frequency of meeting other flow targets established by USFWS would not change
  - ➔ *Small effect, low certainty*

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Sturgeon: Adverse Effects

- Reduced migration flows for early life stages in some water year types
  - Sacramento and Feather rivers (C.5.3.1.9)
    - White: Juvenile (July through September); up to 52% lower
    - Green: Larval (August through October) and juvenile/young of year (August through June); up to 69% lower
  - ➔ *Moderate effect, moderate certainty*

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Sturgeon: Other and Net Effects

- No effect on other important stressors
  - Water temperatures during upstream and in-Delta presence
  - Instream flows during larval rearing
  - Contaminants
  - Legal harvest
- Net Effect
  - Small benefits, low certainty

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Lamprey: Beneficial Effects

- Reduced redd dewatering (C.5.2)
  - Sacramento and American rivers
  - No change in Trinity and Stanislaus rivers
  - Increase in Feather River
  - ➔ *Small effect, low certainty*

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Lamprey: Beneficial Effects

- Reduced entrainment at south Delta (B.6.1)
  - 50% reduction in salvage
  - ➔ *Small effect, low certainty*

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Lamprey: Beneficial Effects

- Improved Passage
  - CM2 Yolo Bypass Fisheries Enhancements (C.5.3.1.8)
  - CM 14 Stockton Deep Water Ship Channel (C.5.3.1.6)
  - ➔ *Small effect, low certainty*

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Lamprey: Beneficial Effects

- Improved adult attraction cues in San Joaquin River
  - CM2 Yolo Bypass Fisheries Enhancements (C.5.3.1.8)
  - CM 14 Stockton Deep Water Ship Channel (C.5.3.1.6)
  - ➔ *Small effect, low certainty*

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Lamprey: Adverse and Net Effects

- Increased predation at new North Delta intakes
  - Changes to hydrology and increase in hiding spots
  - ➔ *Small effect, low certainty*
- Net Effect
  - Small benefit, low certainty

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Terrestrial Species

49 Terrestrial Covered Species

- 6 mammals
- 12 birds
- 2 reptiles
- 3 amphibians
- 6 invertebrates
- 19 plants

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Terrestrial Species

Endemic or Near-Endemic to Plan Area

- Suisun song sparrow
- Delta mudwort
- Suisun marsh aster
- Suisun thistle

Substantial Portion of Range in Plan Area

- Riparian brush rabbit
- Riparian woodrat
- Suisun shrew
- Carquinez goldenbush
- Mason's lilaeopsis
- Delta tule pea
- Soft bird's-beak
- Heckard's peppergrass

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Methods: Habitat Models (Appendix 2A)

- Expert-based models of suitable habitat parameters mapped on large scale
- Used vegetation and physical data
- Conservative
- Differentiation by life history requisites
- Differentiated habitat quality in some cases
- Habitat suitability indices for a few species using cultivated lands, quality categories for some other species

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Species Occurrence Data

- Generally not used to develop habitat models because occurrence data is incomplete and biased for most species
- Used to verify and refine models as needed
- Used to supplement effects on covered plant species

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Methods: BDCP Actions

- Water facilities footprint layer
- Hypothetical tidal and floodplain restoration footprint GIS layer
- Other assumptions related to BDCP actions (Yolo bypass inundation, other restoration activities) Table 5.K-1

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Methods: Indirect Effects

- Assumed distance from edge of activity within which indirect effects occur (noise, dust, hydrologic effects)
- Distance varied by species, based on species sensitivity to disturbance (Table 5.K-4)
- Applied indirect effect distance to GIS data as a buffer around direct effect footprints

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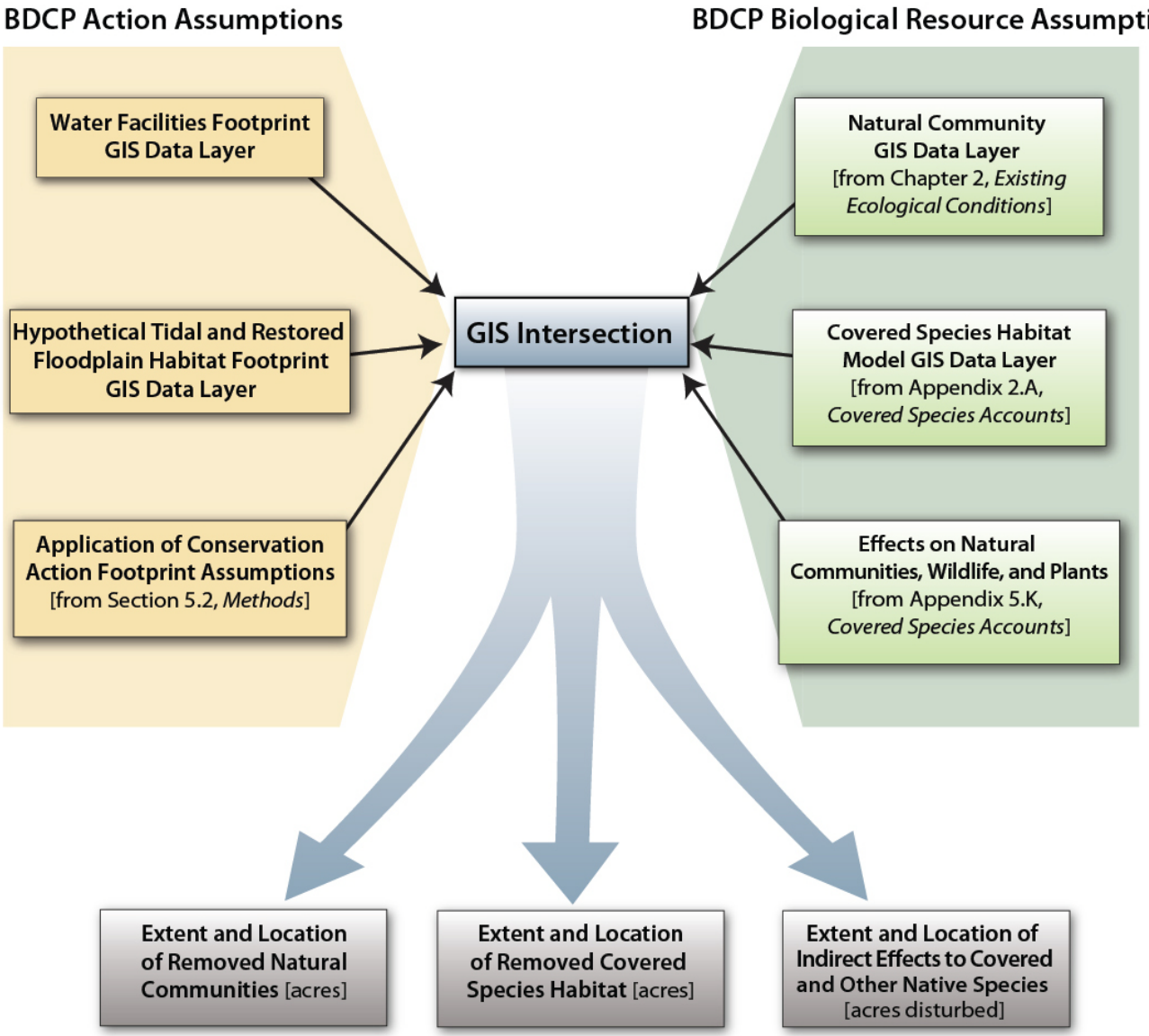
BDCP Assumptions



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BDCP Net Effects: Terrestrial Species

- Adverse effects on most species relatively low
- Substantial effects from loss of cultivated land on Swainson's hawk, sandhill crane, tricolored blackbird are offset by conservation
- Tidal wetland restoration provides long-term benefits but short-term effects may be substantial for some species
  - Minimized through careful siting and design
- BDCP provides substantial benefits to all 49 terrestrial species

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Example Species Effects

- Swainson's hawk (Sect. 5.6.13)
- Riparian brush rabbit (Sect. 5.6.1)
- Giant garter snake (Sect. 5.6.19)
- Brittlescale (Sect. 5.6.26)

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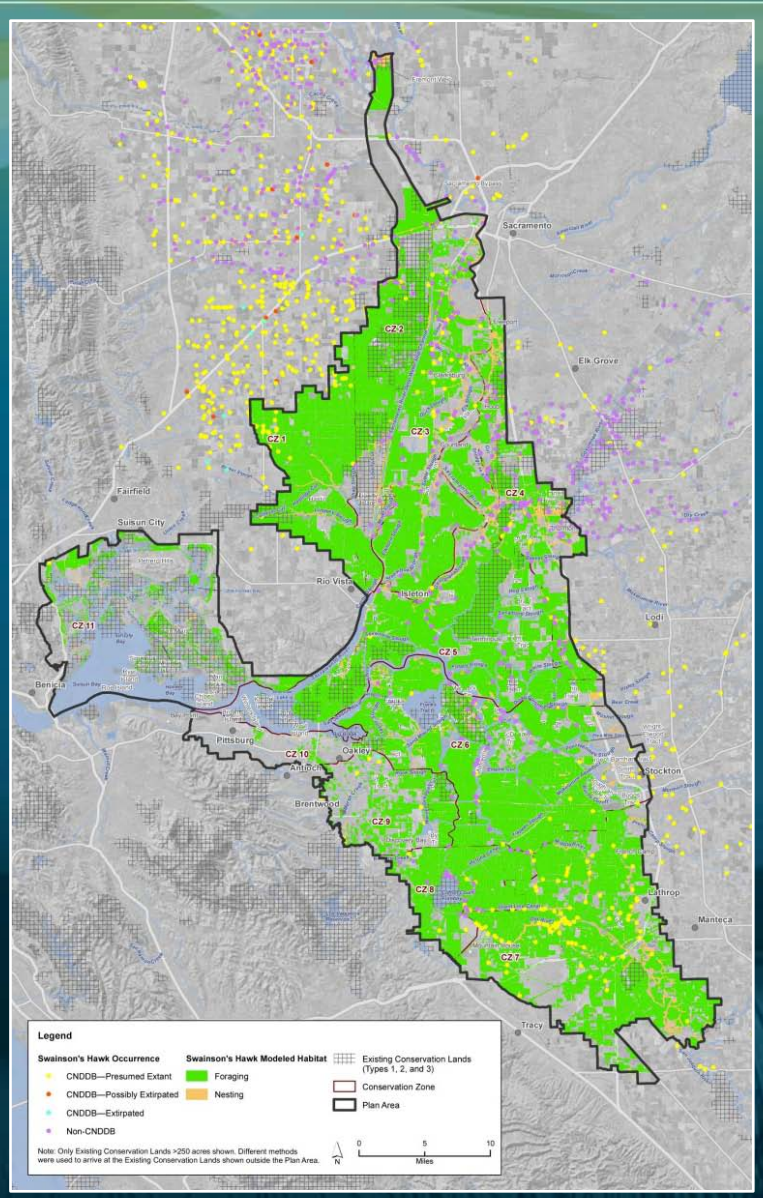
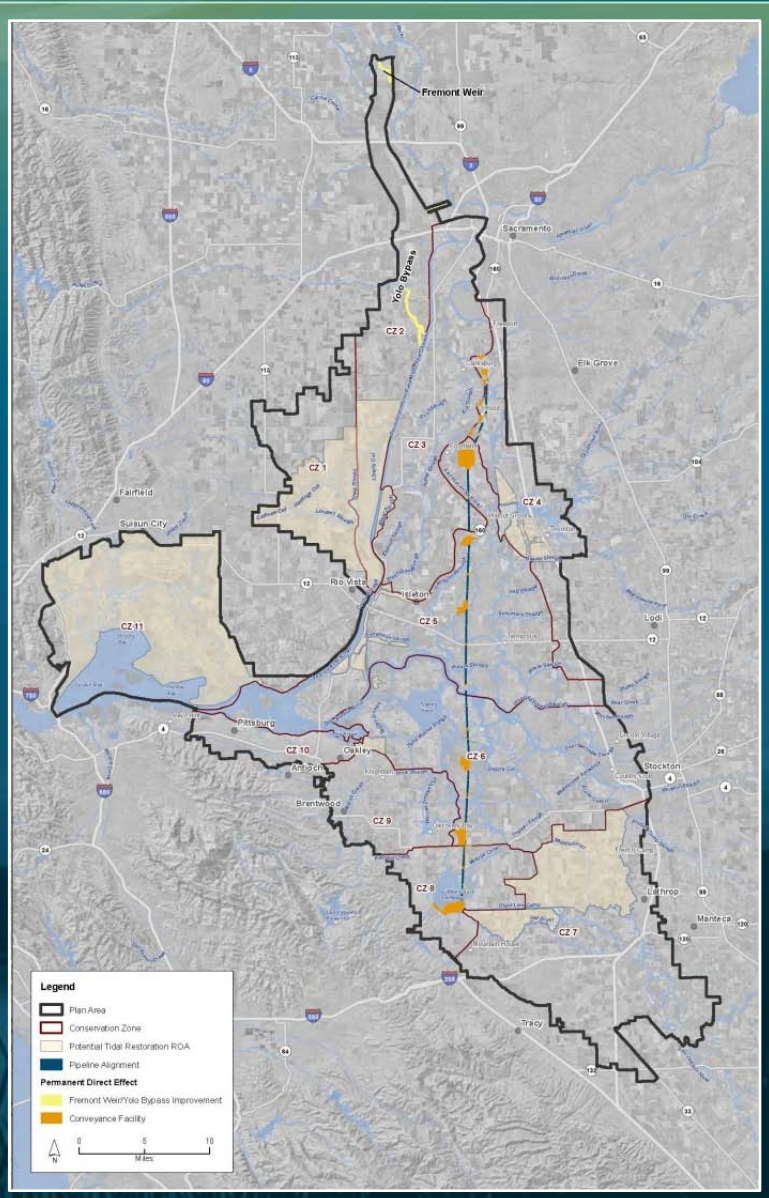
Swainson's Hawk Habitat Model

Impact overlay





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Swainson's Hawk

Foraging Habitat Value Class	Agricultural Crops and other Cover Types	Foraging Habitat Value	Acres Affected	Habitat Units
Very high	Alfalfa hay	1.0	9,198	9,198
High	Irrigated pasture, other hay crops	0.75	3,606	2,705
Moderate	Tomatoes, sugar beets, grain crops (wheat, barley, oats), grasslands, managed wetlands, vernal pool grasslands, alkali seasonal wetlands	0.5	10,890	5,445
Low	Other irrigated field and truck/berry crops	0.25	3,540	885
Very low	Safflower, sunflower, corn, grain sorghum	0.1	4,686	469
Totals			31,920[1]	18,700

[1] Foraging habitat loss from riparian restoration, which totals 4,962 acres, is not included in the calculations because it was not possible to determine precise locations or habitat value class of the affected habitat.

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Swainson's Hawk: Adverse Effects

- Permanent loss of 31,920 acres (18,700 HSUs) foraging habitat (7% of total in Plan Area)
- Temporary loss of 2,476 acres (0.6%) foraging habitat
- Permanent loss of 671 acres (7%) nesting habitat
- Temporary loss of 144 acres (1%) of nesting habitat
- Indirect effect to 1,371 acres of foraging and 505 acres of nesting habitat (within 1,300 feet of activity

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Swainson's Hawk: Beneficial Effects

- Protection and management of 24,647 to 36,344 acres (18,700 HSUs) foraging habitat
- Protection of 750 acres riparian
- Restoration of 5,000 acres of riparian
- Protection and maintenance of isolated nesting trees, and management to increase prey base

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Swainson's Hawk: Net Effects

- 17 to 39% increase in protected Swainson's hawk habitat
- 109% increase in protected nesting habitat
- 32% net increase in nesting habitat

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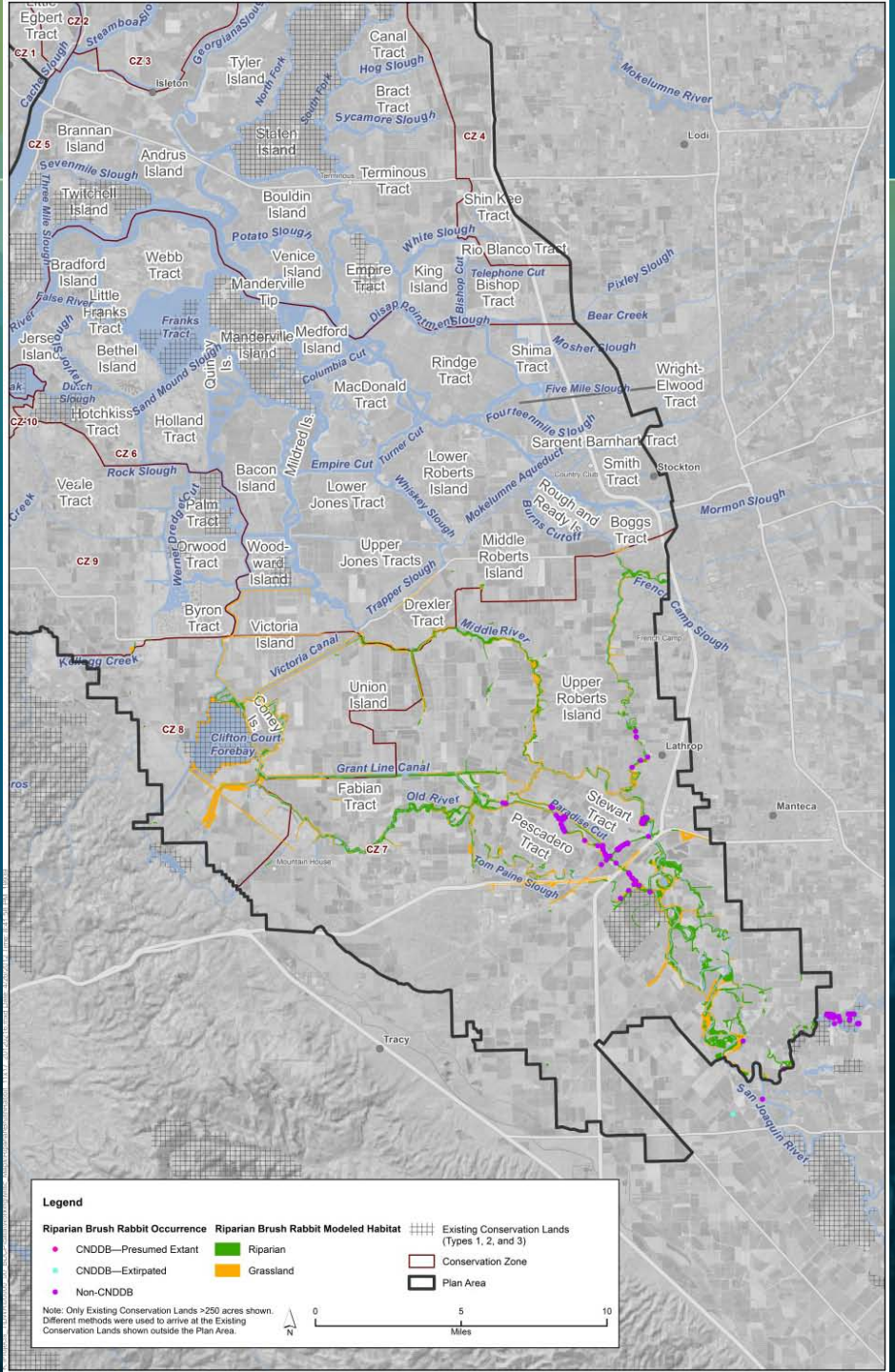
Riparian brush rabbit habitat model



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Riparian Brush Rabbit: Adverse Effects

- Permanent loss of 63 (2%) acres modeled riparian habitat
- Permanent loss of 175 acres (10%) adjacent grassland habitat
- Temporary loss of 165 (6%) acres modeled riparian habitat
- Temporary loss of 32 acres (1%) adjacent grassland habitat
- No additional indirect effects

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Riparian Brush Rabbit: Beneficial Effects

- Protection of 200 acres occupied habitat
- Restoration of 300 acres with specific habitat requirements (net 26% habitat increase)
- Creation and maintenance of flood refugia
- Restoration and protection of adjacent grasslands
- Predator control

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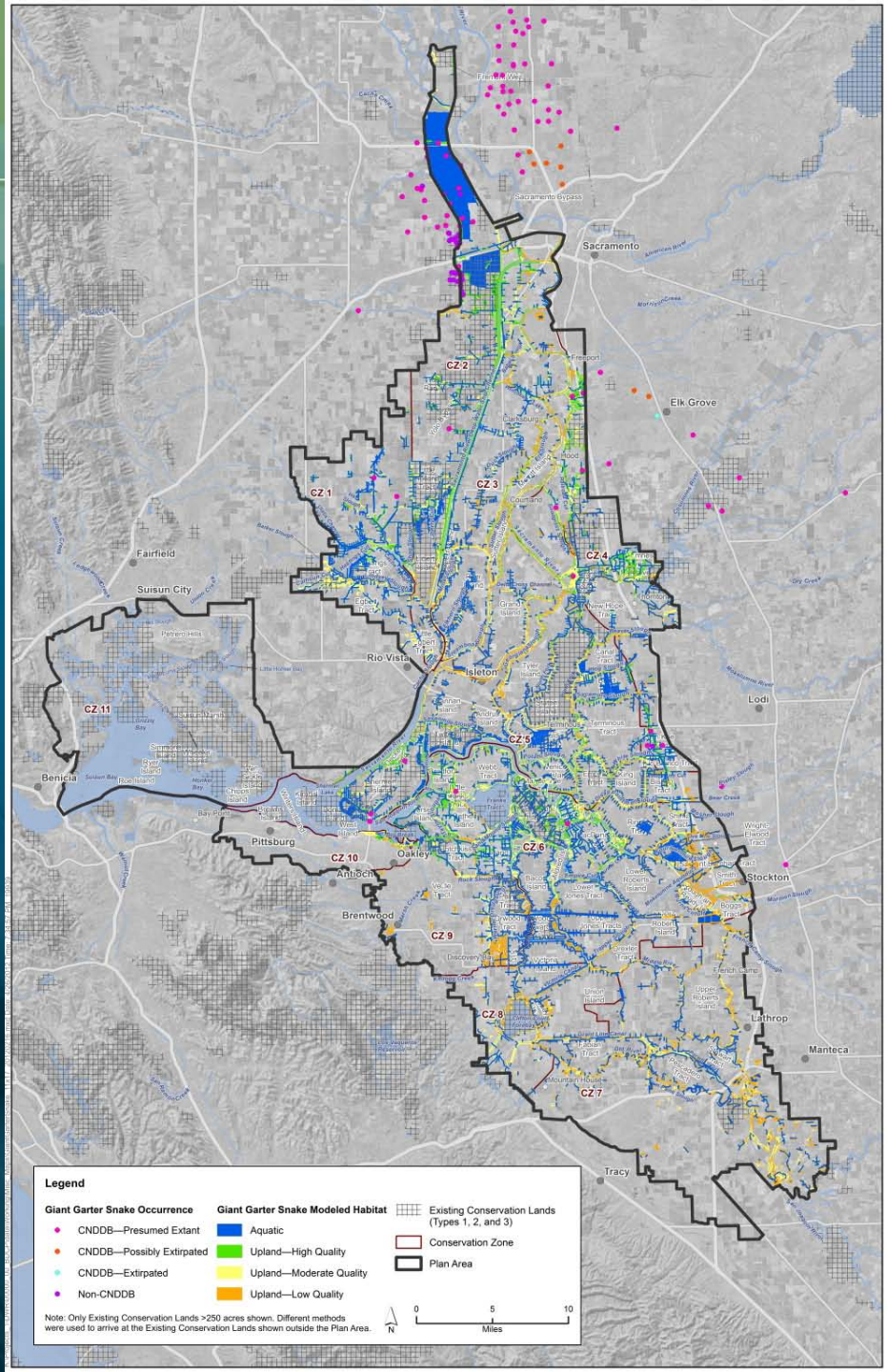
Giant garter snake habitat model



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Giant Garter Snake: Adverse Effects

- Loss of 838 acres aquatic habitat (3% of total in Plan Area)
- Loss of 96 miles of channels (7%)
- Loss of 935 acres high-, 3,063 acres moderate-, and 1,738 acres low-value upland habitat (6%)
- Indirect impacts within 500 ft:
  - 77 acres of aquatic
  - 173 acres high-value upland
  - 200 ac moderate- and low-value upland

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Giant Garter Snake: Beneficial Effects

- Aquatic: 502 acres protected and 9,888 acres restored
- High-value upland: 172 acres protected and 343 acres restored
- Moderate/low-value upland: 2,027 acres protected and 3,605 acres restored
- Reserves in two important recovery areas, Willow Slough and White Slough: 200 acres restored nontidal aquatic and 100 acres restored upland in each

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Giant Garter Snake: Net Effects

- 31% increase in aquatic habitat
- 3% decrease in high-value upland
- 2% decrease in moderate- and 1% decrease in low-value upland
- 53% increase in protected habitat

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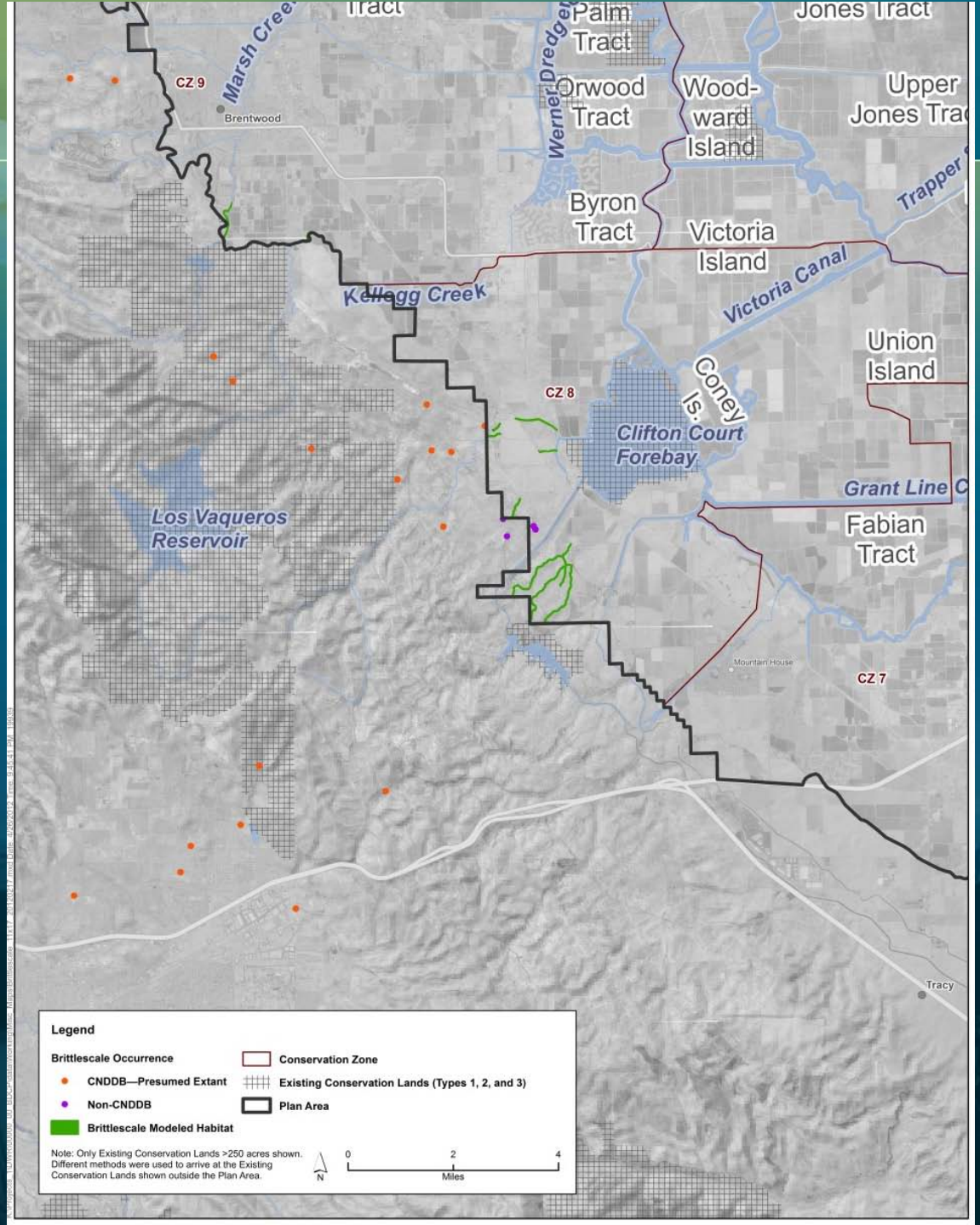
Brittlescale modeled habitat



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Brittlescale

- Permanent loss of 3 acres modeled habitat (0.4% of habitat in Plan Area)
- Restoration of 113 acres and protection of 536 acres of alkali seasonal wetland complex, grassland, and vernal pool complex natural communities expected to be suitable habitat
- Net 111 acre (24%) habitat decrease
- Net 648 acre (515%) increase in protected habitat

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BDCP Net Effects: Terrestrial Species

- Adverse effects to most species relatively low
- Model "effects" on vernal pools from restoration can be avoided
- Substantial effects from loss of cultivated land on foraging habitat of three species:
  - Swainson's hawk, sandhill crane, tricolored blackbird
  - Conservation of 25,000 to 32,000 acres of cultivated land will offset effects and contribute to recovery for all three species
  - Conservation and restoration of breeding sites for Swainson's hawk and blackbird will contribute to recovery

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BDCP Net Effects: Terrestrial Species

- Tidal wetland restoration effects
  - Potential for temporary adverse effects to salt marsh harvest mouse, Suisun shrew
  - Long-term benefits to species from increase in tidal marsh habitat
  - Careful phasing and design of restoration in Suisun Marsh will minimize short-term adverse effects

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BDCP Net Effects: Terrestrial

- BDCP mitigates and contributes to recovery for all 49 terrestrial species
- Provides substantial long-term conservation for many species through
  - Strategic land protection
  - Habitat restoration
  - Population creation (plants)
  - Long-term monitoring and targeted research
  - Facilitates climate change adaptation